CULTIVATING CONVERSATIONS

DISCOVERING FARMLAND

ABOUT FOOD & AGRICULTURE

Water Budget

Exploration Activity for "Your Shopping Experience"

Time: 1 session, 45-60 minutes

Overview:
Per the Food and Agriculture Organization of the United Nations, natural disasters caused $1.5 trillion U.S. dollars of economic damage worldwide from 2003 to 2013. Floods, droughts and tropical storms are the natural calamities that impact agriculture the most.[1] Natural disasters impact farmers' and ranchers' livelihoods and the food options available at the grocery store.

Because weather conditions have a major impact on agriculture, it is essential that farmers and ranchers possess a solid understanding of their land's water budget. A water budget is a measurement of the water that flows into and out of a specific area. The formula for calculating a water budget looks like this:[2]

ΔS (storage) = P (precipitation) - E (evaporation) - ET (evapotranspiration) +/- SRO (surface runoff) +/- GF (groundwater flow)

If the numbers on the right-hand side of the equation add up to a positive number, then there will be an excess of water. If they are negative, it means there is a water deficit. Farmers and ranchers must make decisions about what to grow and how to grow it based on the availability of water on their land. They also select specific conservation practices and adopt new technology to save water. This affects how livestock are raised and what crops they can grow. Farmers facing drought conditions might consider growing crop varieties that have been genetically modified to resist the effects of a drought. Ranchers in arid conditions might not be able to supply animals with fresh grass and might instead feed their livestock with hay or corn. These practices help the farmer or rancher to maintain a stable living, ensure a steady supply of products at reasonable prices and prevent food shortages.

In this activity, students will be given a prompt that asks them to prepare a water budget for a new farm that has been planned. They will utilize the data given in the prompt to calculate the water budget and determine if the new farm will face either a water deficit or surplus. Students will use the information they learn from this activity and the digital exploration to construct an argument about how crops that are genetically modified to resist drought make farmers' livelihoods more secure and keep our food supply stable.

Objectives:
Students will be able to:

- **Understand** how water availability and weather patterns affect agricultural practices
- **Analyze** how water availability affects the decisions that agriculture professionals make
- **Evaluate** how food marketing labels impact all individuals involved in getting food from the farm to the table

Materials:

- Water Budget workbook— one per student
- Computer with access to the internet
- Chalkboard or whiteboard

Have you ever wondered . . .

How farmers and ranchers make a living?

Farmers and ranchers operate like business owners. For any business to remain profitable, they must make sure that they keep costs low while maintaining steady income. Farmers and ranchers are subject to many unpredictable forces, including weather, economic demand and evolving technology. They rely on the work of economists, scientists, marketing specialists and transportation professionals to grow nutritious crops and sell them to consumers.

How weather conditions impact the foods we eat?

There are many factors that impact the prices and availability of the foods we eat, but weather is the biggest. We often see farmers who choose to grow crops like corn and wheat. These crops have genetically-modified strains that protect them from drought. Farmers' income depends on the crops and livestock they raise, so it is important that farmers have crops that are hearty enough to withstand changes in weather. If a crop is wiped out because of a drought or flood, it makes it less available to consumers and more expensive to purchase.

Make connections!

How does this connect to students?	**How does this connect to careers?**	**How does this connect to our world?**
Each student is faced with choices about what to eat. Food marketing specialists use labels like "non-GMO" or "GMO free" to imply that foods that do not include GMOs are more nutritious than foods that have GMOs. However, genetically modified crops have been extensively tested and offer just as much (and sometimes more) nutritional value as non-GMO crops. In this activity, students will learn to think critically about marketing labels and how they impact individuals along the agricultural supply chain.	**Buyers and Purchasing Agents** Buyers and purchasing agents buy products and services for stores, restaurants, and other businesses. They evaluate the quality of a product and assess its desirability at market.[3] **Hydrologists** Hydrologists study water quality and availability. They test for contamination, chart water ground flow and devise best practices for keeping water safe for various uses.[4] **Atmospheric Scientists and Meteorologists** Meteorologists and atmospheric scientists study weather and help us understand how it impacts our daily lives.[5]	The world's population is growing and in need of reliable food sources. Weather patterns of the past and present and provide important insights into how we might face issues like food shortage and crop disease in the future.

Blueprint for Discovery

Background and example water budget (10 minutes)

1. Draw a T-chart on the board. On one side of the chart, write “water sources.” On the other side of the chart, write “water uses.”
2. Ask students to think about different ways we get water. Answers might include precipitation, groundwater/wells, irrigation, lakes, streams, rivers, oceans, etc. Write the answers under the “water sources” area of the chart.
3. Ask students to think of all the different ways water is used on a farm. Answers might include irrigation, normal household use, livestock, etc. Write the answers under the “water uses” area of the chart.
4. Explain to students that a percentage of the water we use is subject to evaporation and evapotranspiration, which is the evaporation of water through plants. Add evaporation and evapotranspiration to the chart under “water uses.”
5. Explain to students that we have formed the beginnings of an important equation—a water budget. By subtracting our water uses from our water sources, we can see if we have an excess of water, a water shortage, or the right amount of water.
6. Ask students to think about what would happen if a farm had a water budget that was too high or low. Have students share their answers in pairs.

Water budget activity (15-20 minutes)

1. Ensure that each student has a copy of the Water Budget activity capture sheet. Each student should also have access to a computer, tablet or smartphone which they will use to access the EPA water budget calculator website.
2. Inform students that they will take part in a simulation in which they will act as farmers and calculate their own water budget.
3. Provide students with 15-20 minutes to calculate their water budgets and answer the questions on the activity sheet. Students should find that their farm will have adequate water for the intended uses.

Making choices (15-20 minutes)

1. Once students have completed their activity sheets, divide students into groups of 5.
2. Each student should have a copy of the Making Choices capture sheet.
3. Ask each group to think about how natural disasters impact the lives of famers, consumers and a variety of agriculture professional. Assign each student in a group with two of the individuals in the “Individual” column of the Making Choices capture sheet. Provide students with 5 minutes to research how a food shortage impacts their assigned individuals. Provide groups with 10 minutes to share their research, acting as “experts” to educate the rest of their group on their two individuals.
4. Have each group report their answers. Explain to students that the labels we see on food are often misleading and don’t necessarily offer benefits to the individuals who rely on agriculture for employment and sustenance. GMO crops are important for sustaining the world’s growing population and protecting farmers and ranchers from the economic effects of drought and disease.

Take action!

Want to extend the learning on consumer purchasing, agriculture and genetically modified organisms? Explore these resources and classroom activities:

National Agriculture Literacy Matrix: Evaluating Perspectives About GMOs

National Center for Atmospheric Research: Flood Chances Classroom Activity

University of Pennsylvania Wharton School of Business: Making A Purchase—Understanding the Consumer Decision-Making Process

National Standards

Science	Next Generation Science Standards • **HS-ESS2-2 Earth's Systems** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. • **HS-ESS3-1 Earth and Human Activity** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. • **HS-ETS1-3 Engineering Design** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. • **HS-ESS3-6 Earth and Human Activity** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. • **HS-ESS2-5 Earth's Systems** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. Common Core Mathematical Standards • **CCSS.MATH.CONTENT.HSA.CED.A.1** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. • **CCSS.MATH.CONTENT.HSA.CED.A.3** Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

Works Cited

1. Food and Agriculture Organization of the United Nations. “The impact of disasters on agriculture and food security.” 2014. http://www.fao.org/3/a-i5128e.pdf.
2. Atlas of Resources in the Black Hills Area, South Dakota. “Hydrologic Budgets.” https://pubs.usgs.gov/ha/ha747/pdf/hydrologic-budgets.pdf
3. U.S. Bureau of Labor Statistics. “Occupational Outlook Handbook: Buyers and Purchasing Agents.” December 17, 2015. https://www.bls.gov/ooh/business-and-financial/buyers-and-purchasing-agents.htm
4. U.S. Bureau of Labor Statistics. “Occupational Outlook Handbook: Hydrologists.” December 17, 2015. https://www.bls.gov/ooh/life-physical-and-social-science/hydrologists.htm
5. U.S. Bureau of Labor Statistics. “Occupational Outlook Handbook: Atmospheric Scientists, Including Meteorologists.” December 17, 2015. https://www.bls.gov/ooh/life-physical-and-social-science/atmospheric-scientists-including-meteorologists.htm

Water Budget
Activity Capture Sheet

Objective
You are a farmer who is planning to construct a new farm in Doylestown, Pennsylvania. You plan to dedicate most of your land to crops but you also have a small number of livestock. You are currently considering a plot of land for your farm but you want to calculate a water budget to make sure the land will be able to support your farming needs. To do this, you must:

1.) Read the land description below and identify the data you will need to create your water budget.
2.) Use the EPA Water Budget Tool to calculate the water budget.[5]
3.) Write the water budget here: _____
4.) Answer the critical thinking questions below.

Land Description
This 10-acre plot in Doylestown, PA has been maintained as a family farm for over 50 years. The farm features 5 acres of tilled fields with a high demand for water and 5 acres of grassy pasture with a low demand for water. The peak waterfall month is June. The average rainfall is 3.39 inches per month and 6.16 inches/month of evapotranspiration (ETo). The farm has a built-in drip irrigation system.
Hint: You will need to use a converter to convert acres into square feet!

Based on the calculations, does this land have sufficient water for your farm's needs? Does it impact the crops you would choose to grow? How would you divide the land amongst your crops and livestock?

How would your farm be impacted in the case of a flood? In the case of a drought?

How does the availability of water affect the way a farmer might approach the following practices?

1. **Fertilization:**

2. **Pesticide use:**

3. **Free-range and/or cage-free grazing:**

Making Choices
Activity Capture Sheet

Imagine that you are a farmer in the Southwestern United States. Your main crops are corn and soybeans. A widespread drought has killed over half of your corn yield in this growing season. Write the impact that this natural disaster would have on the agriculture supply chain "Impact" column of the chart below. Now, consider how the impact would be different if you used a variety of corn that had been genetically modified to be drought-resistant. Write your answers in the "GMO Crop" column of the chart.

Individual	Impact	GMO Crop
Farmer/Rancher		
Farm Laborer		
Processing Facility		
Product Tester/Regulator		
Transportation Specialist		
Food Marketer		
Purchasing Agent		
Retailer		
Restaurant Owner		
Consumer		